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**XXVI. A Series of Observations on, and a Discovery of, the Period of the Variation of the Light of the bright Star in the Head of Medusa, called Algol. In a Letter from John Goodricke, Esq. to the Rev. Anthony Shepherd, D. D. F. R. S. and Plumian Professor at Cambridge.**

Read May 15, 1783.

SIR,

York, May 12, 1783.

I TAKE the liberty to transmit to you the following account of a very singular variation in Algol or  $\beta$  Persei, which you will oblige me by presenting to the Royal Society, if you think it deserving that notice. All that has been hitherto known concerning the variation of this star, as far as I can find after the most diligent researches, is comprised in the following passage in DU HAMEL's *Historia Regiae Scientiarum Academæ, liber IV. sect. 6. caput VIII. de rebus Astronomicis*, ann. 1695, p. 362. "Id quoque testatur D. MONTANARI stellam lucidiorem "Medusæ, diversis annis, variæ esse magnitudinis: nullam pene "in eâ mutationem potuit advertere D. MARALDI annis 1692: "et 1693; sed anno 1694 aucta est et immunita insigniter, modo "quarti, modo tertii, modo secundi ordinis stella apparuit." This, however curious, is only a very vague and general information; but the following observations, lately made, exhibit a regular and periodical variation in that star, of a nature hitherto, I believe, unnoticed.

The first time I saw it vary was on the 12th of November 1782, between eight and nine o'clock at night, when it appeared of about the fourth magnitude; but the next day it was of the second magnitude, which is its usual appearance. On the 28th of December following, I perceived it to vary again thus; at  $5^{\circ}\frac{1}{2}$  h. in the evening, it was about the fourth magnitude, as on the 12th of November last; but at  $8\frac{1}{2}$  h. I was much surprised to find it so quickly increased as to appear of the second magnitude. My friend Mr. EDWARD PIGOTT, whom I informed of this singular phænomenon as soon as I saw it, also observed it; and I had the pleasure to find that his observations coincided with mine. The subsequent observations which I have made on this star are very particular; and I think it will be best to give a brief extract of them in their order from my journal; but it is necessary I should first specify the usual and greatest magnitude of Algol, as also the relative brightness and magnitude of those stars to which I compared it during the progress of its variation.

The usual and greatest magnitude of Algol is this; of the second magnitude, much less bright than  $\alpha$  Persei, and not so much as  $\gamma$  Andromedæ; brighter than  $\alpha$  Cassiopeæ and  $\beta$  Arietis, and nearly the same, if not rather brighter, than  $\alpha$  Pegasi and  $\beta$  Cassiopeæ; not quite so bright as  $\gamma$  Cassiopeæ, and much brighter than  $\epsilon$  Persei and  $\beta$  Trianguli. The relative brightness of the stars to which I compared it during the progress of its variation is as follows;  $\alpha$  Cassiopeæ is the brightest, and of near the second magnitude;  $\beta$  Arietis is the next, and of between the second and third magnitude; then  $\epsilon$  Persei and  $\beta$  Trianguli, both of the third magnitude;  $\zeta$  Persei is somewhat less bright than  $\epsilon$  Persei, and also of the third magnitude;  $\delta$  Persei is less than  $\zeta$  Persei, and rather of between the third and

and fourth magnitude;  $\varrho$  Persei, which Algol is equal to at its least brightness, is not so bright as  $\delta$  Persei, and of about the fourth magnitude.

## OBSERVATIONS ON ALGOL.

*Brightness and magnitude of Algol.*

January 14, 1783.

At 6 h. it was varied from its usual brightness, but rather brighter than  $\beta$  Arietis.

At  $6\frac{3}{4}$  h. equal to  $\beta$  Arietis, but rather a little less bright, and of between the second and third magnitude.

At  $7\frac{1}{4}$  h. third magnitude; not so bright as  $\beta$  Arietis, and equal to  $\beta$  Trianguli.

At  $7\frac{3}{4}$  h. nearly the same as at  $7\frac{1}{4}$ , but thought it was rather less bright than  $\beta$  Trianguli.

At  $8\frac{3}{4}$  h. between the third and fourth magnitude; not quite so bright as  $\beta$  trianguli, and rather less than  $\epsilon$  and  $\zeta$  Persei, but a little brighter than  $\delta$  and  $\varrho$  Persei.

At  $9\frac{1}{4}$  h. about the fourth magnitude, and equal to  $\varrho$  Persei.

The weather was cloudy till  $11\frac{3}{4}$  h. when it appeared to be of the third magnitude; much brighter than  $\varrho$  Persei, and rather brighter than  $\gamma$  Persei.

At  $12\frac{1}{4}$  h. between the second and third magnitude, and brighter than  $\zeta$  and  $\epsilon$  Persei and  $\beta$  Trianguli.

January 17.

At  $7\frac{3}{4}$  h. it was of the third magnitude, equal to  $\epsilon$  Persei, and rather less than  $\beta$  Trianguli.

At 8 h. a very little brighter than  $\epsilon$  Persei, and equal to  $\beta$  Trianguli.

At

At  $8\frac{1}{4}$  h. rather brighter than  $\beta$  Trianguli, but the sky was not favourable.

### January 31.

At  $10\frac{1}{2}$  h. varied from its usual brightness, but with some doubt.

At  $11\frac{1}{4}$  h. certainly less bright; much less than  $\gamma$  Andromedæ, but brighter than  $\zeta$  and  $\epsilon$  Persei, and of between the second and third magnitude.

At  $12\frac{1}{4}$  h. third magnitude, and rather brighter than  $\zeta$  and  $\epsilon$  Persei.

At  $13$  h. about the brightness of  $\zeta$  Persei, and much brighter than  $\rho$  Persei; but the sky was not favourable.

At  $14\frac{1}{4}$  h. about the fourth magnitude, and equal to  $\rho$  Persei, but afterwards increased.

### February 6.

At  $5\frac{1}{2}$  h. it was rather a little brighter than  $\beta$  Arietis, and between the third and fourth magnitude.

At  $6\frac{1}{4}$  h. about the third magnitude; not so bright as  $\beta$  Arietis, but brighter than  $\beta$  Trianguli and  $\epsilon$  Persei.

At  $6\frac{1}{2}$  h. about the same brightness as  $\beta$  Trianguli and  $\epsilon$  Persei.

At  $7$  h. between the third and fourth magnitude; not quite so bright as  $\beta$  Trianguli, nearly equal to  $\delta$  Persei, and a little brighter than  $\rho$  Persei.

At  $7\frac{1}{2}$  h. about equal to  $\rho$  Persei, and nearly of the fourth magnitude; but the sky was not favourable.

At  $8$  h. rather a little less bright than  $\rho$  Persei; sky still unfavourable.

At  $8\frac{1}{2}$  h. between the third and fourth magnitude rather a little brighter than  $\delta$  Persei, and a little brighter than  $\rho$  Persei.

At  $9$  h. certainly brighter than  $\delta$  Persei, and of the third magnitude.

At

At  $9\frac{1}{2}$  h. of the same brightness as  $\epsilon$  Persei; but the sky was not favourable.

At 10 h. brighter than  $\epsilon$  Persei.

At  $10\frac{1}{2}$  h. brighter than at 10 h. and of between the second and third magnitude.

At  $11\frac{1}{2}$  h. very bright; and now, as I think, at its usual magnitude.

On the 9th of February, at  $6\frac{3}{4}$  h. I thought it was less bright, and nearly equal to  $\beta$  Arietis; but have some doubts on account of the unfavourable sky.

#### February 23.

At  $10\frac{1}{2}$  h. it was brighter than at  $9\frac{1}{2}$  h. when I observed it at its usual brightness; now of the third magnitude, rather brighter than  $\epsilon$  and  $\zeta$  Persei.

At 11 h. about the same brightness as  $\epsilon$  and  $\zeta$  Persei.

At 12 h. between the third and fourth magnitude; not so bright as  $\epsilon$  and  $\zeta$  Persei, a little brighter than  $\varrho$  Persei, and a little less than  $\delta$  Persei.

#### February 26.

At  $6\frac{3}{4}$  h. between the second and third magnitude; rather less bright than  $\alpha$  Cassiopeæ, but was not very certain.

At  $9\frac{1}{2}$  h. little less bright than  $\varrho$  Persei, and of the fourth magnitude.

At 10 h. nearly between the third and fourth magnitude; a little brighter than  $\varrho$  Persei, and a little less bright than  $\delta$  Persei.

#### March 1.

At  $8\frac{1}{2}$  h. it was of the third magnitude; a little brighter than  $\epsilon$  and  $\zeta$  Persei.

At  $8\frac{1}{2}$  h. brighter than at  $8\frac{1}{2}$  h.

At

At  $9\frac{1}{4}$  h. between the second and third magnitude; a little less bright than  $\alpha$  Cassiopeæ.

At 10 h. I believe it now at its usual brightness.

March 18, at  $9\frac{1}{2}$  h. Mr. E. PIGOTT thought it less bright; but the weather was very hazy.

### March 21.

At  $7\frac{1}{2}$  h. it was about between the third and fourth magnitude; not so bright as  $\delta$  Persei, but brighter than  $\varrho$  Persei.

At 8 h. rather a little brighter than  $\varrho$  Persei, and sometimes equal to it.

At  $8\frac{1}{2}$  h. about the fourth magnitude; equal to  $\varrho$  Persei; but sometimes it appeared rather a very little brighter.

At 9 h. rather a little brighter than  $\varrho$  Persei.

At 10 h. about the third magnitude; equal to  $\zeta$  and  $\epsilon$  Persei, but rather a little brighter.

At  $10\frac{1}{2}$  h. brighter than  $\zeta$  and  $\epsilon$  Persei.

At 11 h. much brighter than  $\zeta$  and  $\epsilon$  Persei; rather between the second and third magnitude.

### April 10.

At 8 h. it was about the third magnitude, and rather brighter than  $\epsilon$  Persei.

At  $8\frac{1}{2}$  h. nearly equal to  $\epsilon$  Persei, though rather a little brighter.

At 9 h. rather less bright than  $\epsilon$  Persei, but brighter than  $\delta$  Persei.

At  $9\frac{1}{4}$  h. rather less bright than  $\delta$  Persei, and between the third and fourth magnitude.

At  $9\frac{1}{2}$  h. about the fourth magnitude; not so bright as  $\delta$  Persei, but brighter than  $\varrho$  Persei.

At 10 h. rather less than at  $9\frac{1}{2}$  h.; believe it now very near its least brightness.

April 13.

At 8 h. it was between the third and fourth magnitude; brighter than  $\varrho$  Persei, but not so bright as  $\delta$  Persei.

At  $8\frac{1}{2}$  h. rather brighter than  $\delta$  Persei, and not so bright as  $\epsilon$  Persei.

At 9 h. rather brighter than  $\epsilon$  Persei. It was too low to observe its farther variation.

May 3.

At 9 $\frac{1}{4}$  h. nearly between the third and fourth magnitude, and somewhat brighter than  $\varrho$  Persei; but so low that I could not well compare it with other stars, or be able to observe the remainder of the variation. I believe it must have passed its least brightness not long before.

The times of the above observations are nearly apparent time, and were for the most part made under favourable circumstances. My friend Mr. EDWARD PIGOTT, to whom I am under great obligations on this as well as on other occasions, also observed some of the variations; and where our times of observation were the same, always agrees with me.

From an attentive comparison of all the particulars in the above observations it appears, first, that this star changes from the second to about the fourth magnitude in nearly three hours and a half, and from thence to the second magnitude again in the same space of time; so that the whole duration of this singular variation is only about *seven hours*. And, secondly, it appears also, that this variation probably recurs about every *two days and twenty-one hours*. This last conclusion will be rendered more conspicuous by the following table; the first column of which shews the days, and exact time of the day, when Algol was observed to be very near, or at its least brightness; the second column marks the different intervals of time

elapsed between the several observations; the third exhibits the quotient arising from a division of these intervals by a certain number of revolutions, each of two days and twenty-one hours, which number of revolutions are expressed in the last column.

The day and time when Algol was observed at or near its least brightness.	d. h.	The different intervals between the several observations.	d. h.	The quotients of the divisions of the 2d column by the 4th.	Number of revolutions.
		d. h.	d. h.		
1782 Nov.	12 8 $\frac{1}{2}$	45 21	2 20,8	16	
Dec.	28 5 $\frac{1}{2}$	17 3 $\frac{3}{4}$	2 20,6	6	
1783 Jan.	14 9 $\frac{1}{4}$	17 5	2 20,8	6	
	31 14 $\frac{1}{4}$	5 17 $\frac{3}{4}$	2 21,	2	
Feb.	6 8	17 4	2 20,6	6	
	23 12+	2 21 $\frac{1}{2}$	2 21,5	1	
	26 9 $\frac{1}{2}$	22 23	2 20,9	8	
Mar.	21 8 $\frac{1}{2}$	20 1 $\frac{1}{2}$	2 20,8	7	
April	10 10+	2 22	2 22,*	1	
April	13 8	20 1	2 20,7	7	
May	3 9 $\frac{1}{4}$				

The results in the third column agree so nearly, that there is the greatest probability, not to say certainty, that the singular and quick variation of this star, during the space of seven hours, as above mentioned, recurs regularly and periodically about every two days and nearly twenty hours and three quarters.

To ascertain this period with greater accuracy and precision will require more time and observation: but I can add, that I

\* The difference of upwards of an hour in this quotient will easily be reduced to the others by remarking, that Algol was observed on the 10th and 13th of April, not when it was *at*, but only *near*, its least brightness: and, indeed, all the little differences of the rest will vanish by making a reasonable allowance of the same kind.

have constantly observed Algol, at different times, every night when the weather permitted, ever since the 28th of December last; and upon accurately examining all these observations in my journal, I find, that so far from containing any appearances the least contrary to the above conclusion, they strongly corroborate it, since I never observed that star varied in any of those days which, according to that theory, were the intervals between its variations. All Mr. EDWARD PIGOTT's observations, even at different times from mine, tend to confirm the same conclusion.

Whether this singular phænomenon is always the same; or whether it occurs only some years, and ceases intirely in others (as may be presumed from the account of MONTANARI and MARALDI above quoted); and whether in this case it recurs in regular periods of time or otherwise; are curious objects of investigation, which can only be determined by a long and regular course of observations for many years.

If it were not perhaps too early to hazard even a conjecture on the cause of this variation, I should imagine it could hardly be accounted for otherwise than either by the interposition of a large body revolving round Algol, or some kind of motion of its own, whereby part of its body, covered with spots or such like matter, is periodically turned towards the earth. But the intention of this paper is to communicate facts, not conjectures; and I flatter myself that the former are remarkable enough to deserve the attention and farther investigation of astronomers.

I am, &c.

